

XXVI. *Some breeding experiments on Catopsilia pyranthe and notes on the migration of Butterflies in Ceylon*, by Major NEVILLE MANDERS, R.A.M.C., F.Z.S., F.E.S.

[Read May 4th, 1904.]

PLATES XXXIV AND XXXV.

THE following experiments were preliminary to a more thorough investigation.

I had hoped to have ascertained with exactitude the amount of heat, cold and moisture necessary to produce the various forms in which this insect occurs. The experiments were merely preliminary in order to ascertain the difficulties and the apparatus required to carry out a thorough investigation. They may be of interest because, as far as I know, they are the first experiments made with icing the pupæ of a tropical butterfly. Even these preliminary experiments are far from being complete, as I was ordered home when in the middle of them and had to hand over my notes and material to another entomologist, Mr. Oswin Wickwar, who did what he could in the intervals of a busy official life.

Catopsilia pyranthe occurs in Ceylon under many different forms, three of which besides *Pyranthe* have received names, namely, *Ilea*, *Chryseis* and *Gnoma*. *Gnoma* is usually called the dry-season form and *Chryseis* the wet, and though *Gnoma* is certainly more common in the dry, it is by no means confined to the dry months, neither is *Chryseis* confined to the wet. It may be said that all the forms occur indiscriminately all the year round, and my first object was to ascertain which was the dry form and which the wet, and what would be the several effects of heat, moisture, etc. on the larvæ and pupæ. The first thing was to ascertain the proportion of each variety, and this I left in Mr. Wickwar's hands, and in the month of February 1903, during a migratory flight, he captured sixty specimens, the weather at the time being very dry and hot.

He mentions (and I will allude to this later) that 75 per cent. were males, and 64 per cent. of the total were

marked like Nos. 4, 11 in Plate XXXIV, i. e. *Gnoma*; the striæ in most, however, not being quite so pronounced as in No. 4.

Only four (all females) bore at all heavy markings as in No. 7 (this I should call *C. gnoma*), and in these the coloration of the striæ was of a light yellowish shade, which shade, he says, appears to prevail in the majority of dry-weather females. These sixty insects would appear to be all *C. gnoma*. I have written to ask him to capture this year several hundreds if possible, as I think the numbers too few for a correct estimate.

A large number of larvæ were kept in a glass jar and the atmosphere was kept saturated with moisture, the temperature being about 80° F.; this was also the temperature of the outside air at the time. A considerable number of the pupæ promptly rotted, and the amount of moisture was necessarily reduced. The left-hand series in the photograph shows the result; they all emerged between the 5th and 12th of December and are mostly females. In future experiments I should employ wet and dry bulb thermometers. These five were the only ones that survived.

A considerable number of pupæ, the larvæ of which were reared under normal conditions, were kept at a temperature between 55° F. and 65° F. by means of ice; the result is shown in the second row of the photograph. All emerged between the 9th and 17th of December. The mean temperature of Colombo is 75° F. and the lowest ever recorded is 68° F., the pupæ were therefore 10° to 20° below normal. It was distinctly difficult to keep the pupæ down even to this temperature, but in future, now that there is a cold storage depôt in Colombo, I would try and make use of it for experimental purposes.

The attempt to keep pupæ in an abnormally hot dry atmosphere failed—the pupæ all dried up.

Finally, certain unfortunate larvæ were in an anhydrous atmosphere, a large glass jar with coral unslaked lime. It was exceedingly difficult to keep them alive, as they, the food-plant, and even the eggs shrivelled up. However, by reducing the amount of lime five specimens survived and are shown in column 3; they hatched between 11th and 13th December.

A wet and dry bulb thermometer would be usefully employed in this experiment also.

The results of these experiments are very meagre, only about fifteen to twenty specimens coming to maturity out of quite 200 larvæ. It shows that the constitution of the larvæ is somewhat delicate.*

I mentioned above that Mr. Wickwar had found that 75 per cent. of the insects captured during the dry February flight were males, and quite independently we had observed that the wet-season flight in November and December were almost all females. I cannot account for this further than to say that possibly during the dry months, owing to a more scanty and drier foliage, the female larvæ, if I may use the expression, succumbed; whereas with the damper and more luscious foliage of the wet months they had no difficulty in surviving. The mystery of these migrations may be explained to some extent by this preponderance of the sexes during the different flights.

By a coincidence a migratory flight of butterflies was in full swing on the day I landed in Ceylon, October 25, 1895, and I certainly thought that I had stepped into a land of butterflies. The harbour, streets, and large promenade, the Galle Face by the sea-shore, was alive with butterflies, and being mostly composed of *Catopsilias*, looked for all the world like a snow-storm. In order to gain some idea of their numbers, I selected two points, one at the edge of the sea and the other twenty yards from it, and then counted them as they flew past. The result of my calculation and that of my companion taken separately gave fourteen thousand insects between 10 a.m. and 2 p.m. The flight usually lasts about a week; we have therefore ninety-eight thousand butterflies passing through a space sixty feet broad in twenty-eight hours. In round numbers 100,000.

The sketch map of Ceylon (Plate XXXV) gives the course of these migrations which I have personally observed during the time I was in the island.

There is a distinct difference in procedure between a migratory swarm of butterflies and a swarm of locusts. I mean that the latter advance like a human army so many miles a day from one point to another, and the

* The larvæ were collected in my garden in Colombo, *i. e.* at sea-level; and all, or the very great majority, in the same week; and all from the same food-plants. A considerable number of the eggs were laid by the same female. I used to follow her when she was ovipositing, and snipped off the leaf on which the egg was laid.

country immediately in front of them is clear of them for the time being; whereas in the former, the butterflies in whatever part of the island they happen to be hatched immediately begin to migrate, so that on the same day the migration is as vigorous in one part of the island as in another. As the butterflies hatch in Colombo they immediately fly north, and their places are promptly filled by the insects coming up from Galle, the Galle ones by those from Hambantotte and so on round to Trincomalee, beyond which in the uninhabited country to the north I have been unable to trace them. The proof that the insects on the Trincomalee side really do follow the coast-line and come to Colombo is shown by the fact that it is only during the flights that certain butterflies otherwise confined to that portion of the island, *Papilio Jason* for instance, occur at Colombo, and are there seen migrating in the same frantic haste as their companions.

On one occasion, on December 2, *i. e.* in the wet season, I was observing the flight from Fort Frederick, Trincomalee. The butterflies came from the northern shore straight across the sea to the end of the peninsula on which Fort Frederick is built; several bushes of the food-plant of *C. pyranthe* were growing there, and these were literally covered with eggs, as many as half-a-dozen on a single leaf; the bushes were so speckled with the multitude of eggs that they looked as if handfuls of sago had been scattered over them. The flights in November and December on both sides of the island undoubtedly comprise a majority of females, but scarcely a single larva out of this multitude of eggs could possibly have come to maturity; there was not enough food for half of them, and on a previous migration the bushes not far off were completely stripped by the larvæ.

The insects composing the coast flight are almost entirely *Catopsilias*, two species of *Appias*, *Euplœa ascla*, and *E. montana*, in the hill districts, and *Danaïs septentrionis* irregularly. I should have mentioned that the process of laying eggs was totally contrary to what one usually observes—there was no attempt to choose a suitable leaf, no deliberation displayed about the operation at all, but every female seemed possessed with the one insane idea of getting rid of her eggs with the utmost expedition, utterly regardless of the fate of the future larvæ, and then madly continuing her flight. When in full migration

they fly with great rapidity, and can give points to *Colias edusa*. They select the sea-coast, I feel sure, simply to avoid obstacles. The road between Trincomalee and Kandy, which runs through dense forest, is also largely used by the migrating insects. When travelling south they have the N.E. monsoon behind them, but when turning north they meet a stiff wind which really seems to drive them to a faster flight. The breadth of the flight is usually not more than a quarter of a mile.

The cross-barred line on the map shows one of the lines of migration of the two species of *Appias*, *Paulina* and *Albina*. They both breed in the low country, as shown by the square dots, and fly in a broad belt of insects about a quarter of a mile wide across the open downs at D'lawa, 4,000 feet, and up to the Horton Plains, 7,000 feet, when they turn north toward N'Eliya, 6,000 feet, cross the plateau towards Rambodde Pass at its northern end, and then make their way again to the low country somewhere near Kandy. Part of the flight edges away across the D'lawa Downs northwards and reaches the N'Eliya plateau through the Hakgala Pass.

The migration of *Eupleva montana* starts somewhere in the neighbourhood of the Hortons, and follows much the same course, so far as I know, as *Appias*.

The uninterrupted line is a curious and interesting one; it is that of *Kallima philarchus*, which annually migrates, sometimes in large numbers, though it is usually considered a rare insect. So far as I can at present ascertain there is only one migration annually in November or early in December. The insects come up from the low country to Haldunulle, then up the passes leading to the Hortons, and then across the plains to some uncertain locality, but where I have no idea. The insect does not occur in the Colombo or immediate Kandy districts nor about N'Eliya.

It is extremely difficult to obtain assistance in carrying out an investigation such as this requires. Entomologists are few in number, and, with the exception of Trincomalee and one or two other places, Europeans are confined to Colombo and the Hill district. The remainder of the island is mostly covered with jungle, is thinly inhabited with only here and there a few overworked Government officials and ignorant natives.

The reason for these flights is at present very obscure; it was probably originally a question of food-supply. This

instinct might have arisen from the necessity for constantly seeking new feeding-grounds for the larvæ. As the species increased this tendency to expand would not only preserve the species, but would cause in time its very material increase; the necessity for constantly enlarging the feeding-grounds would in time produce an inherited tendency to migrate. But in due course, when all available feeding-grounds were occupied, as they soon would be in a small island like Ceylon, some check would be required to keep the enormous number of resulting butterflies within due bounds, otherwise the species would be in danger of annihilation from their very numbers. This appears to me to be effected in the following manner: the insects of the wet-season migration are mostly composed of females, and provided that the males can successfully impregnate more than one female, the result would be an enormous number of eggs laid, and this I have shown to be the case. The migratory instinct is so strong that the females are precluded from taking any precautions for their future offspring, as the females of most butterflies do; and the result is that the struggle for existence among the multitude of larvæ subsisting on the food-plant, which is quickly diminishing by their voracity, and also slowly by the heat and dry weather, is so great that the larvæ which would produce female butterflies succumb, and a great majority of males are produced which form the dry-weather flights. This majority of males would also be another factor in checking the increase of the species. During the intervening portion of the year the species would gradually increase, until the wet months at the fall of the year favour a luxuriant vegetation, and all the female larvæ then survive, and possibly being stronger, crowd out the male larvæ. These larvæ produce the overwhelming proportion of females in the next wet-season flight, with the result shown above. This migratory instinct, originally due to a necessity for the increase of the species, is now become a means of preventing its undue propagation.

EXPLANATION OF PLATE XXXIV.

Under-sides of bred specimens of *Catopsilia pyranthe*, Linn.

Nos. 4, 5, 8 are males; the rest females.

The first vertical row (Nos. 2, 1, 7, 6) were kept as larvæ in an atmosphere saturated with moisture.

The second vertical row (Nos. 17, 15, 16, 3, 4) were kept under normal conditions as larvæ, and iced as pupæ.

The third vertical row (Nos. 14, 9, 5, 11, 8) were kept as larvæ in an atmosphere rendered anhydrous by unslaked lime.

In each row the most heavily marked specimens are placed first; the least heavily marked are placed last.

The first two rows tend to be of the form usually called *gnoma*; the last row consists of the form *pyranthe*.

EXPLANATION OF PLATE XXXV.

Sketch Map of Ceylon, showing the migratory flight of various species of Butterflies.

An explanation of the lines employed is given on the Map.